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Towards polaritonics of non-ideal structures

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The design of optoelectronic devices and sources of coherent radiation based on new structures and materials is an extensive interdisciplinary research area that combines condensed matter physics, nanotechnology, laser physics and information science. Wherein optoelectronic devices today, as a rule, exist two types - some function on the basis of excitations of the electronic subsystem of the materials used, while others rely on the optical characteristics of the corresponding structures. When creating the above-mentioned devices, it is necessary to solve a number of problems associated with the formation of a special class of photonic crystals (polaritonic structures), in which a strong coupling of quantum excitations of the medium (excitons) and the electromagnetic field is realized. The study of polaritonic structures is the subject of a new area of photonics, called polaritonics. One of the objects of polaritonics studies, in particular, can be such a polaritonic structure as a spatially periodic atomic system formed by weakly interacting ensembles of two-level atoms and an optical field in a tunnel-coupled array of microporous-resonators. On of the important challenges in this field is controlling the propagation of light in resulting composite structures by subjecting them to various kinds of external actions such as e.g. elastic strains. In this context, a rapidly developing research sub-area is the photonics of imperfect structures. Some of our previous works have been devoted to the design of multi-microcavity structures where the dispersion of photon modes may be altered by introduction of a defect in the photonic supercrystal. For applications, the structural defects in supercrystals are less practical than temporary defects introduces by application of external fields or strain. In the present work we consider the effect of a uniform elastic strain on 1D and 2D arrays of microcavities with embedded quantum dots. This systems combine advantages of an extreme optical non-linearity provide by the coupling of quantum dots to photonic modes and the high sensitivity of the optical eigen-modes to the applied strain. We focus on two particular realizations of topologically ordered microcavity system composed by tunnel-coupled optical microcavities: a two-sublattice array and a one-sublattice array of unevenly spaced spherical microcavities. We show that both systems have a high potentiality for applications in optical integrated circuits.

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